CLAIMS

1. A robust scalable laser system comprising:

plural laser resonators and

a cavity external to said laser resonators, said cavity adapted to combine plural laser beams output from said plural laser resonators into a single output laser beam.

2. The laser system of Claim 1 wherein said plural laser resonators are eye-safe fiber laser resonators.

3. The laser system of Claim 2 wherein said eye-safe fiber laser resonators include double-clad Er:YAG laser resonators.

4. The laser system of Claim 1 further including high-power laser pump sources coupled to said fiber laser resonators.

5. The laser system of Claim 4 wherein said high-power laser pump sources include laser diodes.

6. The laser system of Claim 4 wherein said pump sources are end-coupled via pigtails or discrete imaging optics.

7. The laser system of Claim 4 wherein said pump sources are side coupled, edge coupled, fusion coupled, and/or coupled via a reflective cavity.

8. The laser system of Claim 4 wherein said fiber laser resonators are approximately equivalent lengths or differ in length by approximately more than 1.4 centimeters.

9. The laser system of Claim 8 wherein said cavity incorporates an external spatial filter that includes beam-flattening optics, a lens pair having a filtering

aperture therebetween, and a feedback mirror to facilitate coherent combining and phase locking of said plural laser beams.

10. The laser system of Claim 8 wherein said cavity incorporates a diffractive mode feedback selector.

11. The laser system of Claim 8 wherein said cavity incorporates a free space propagation distance.

12. The laser system of Claim 8 wherein said cavity incorporates a light pipe.

13. An eye-safe laser system comprising:

plural fiber laser resonators adapted to laser at eye-safe wavelengths and

means for combining beams output from said plural fiber laser resonators into a single eye-safe laser beam.

14. The laser system of Claim 13 wherein said means for combining includes an external cavity.

15. The laser system of Claim 14 wherein said plural fiber laser resonators are coupled to plural pump sources.

16. The laser system of Claim 15 wherein said fiber laser resonators include integrated reflectors.

17. The laser system of Claim 16 wherein said integrated reflectors include distributed Bragg reflectors.

18. The laser system of Claim 15 wherein said external cavity includes a spatial filter for coherently combining said beams into said single eye-safe laser beam.

19. The laser system of Claim 18 wherein said spatial filter includes beam-flattening optics adjacent to a pair of collimating lenses, said pair of collimating lenses having a miniature aperture therebetween and positioned adjacent to a partially transmissive feedback mirror.

20. The laser system of Claim 19 wherein said beam-flattening optics are characterized by hexagonal geometry.

21. The laser system of Claim 20 wherein said plural pump sources include diodes.

22. The laser system of Claim 21 wherein said fiber laser resonators are Er:YAG fiber laser resonators.

23. The laser system of Claim 22 wherein said laser resonators include resonator cores that are sufficiently different in length to facilitate longitudinal mode overlap among beams traveling along different resonator cores.

24. The laser system of Claim 21 wherein said plural pump sources include a diode emitter array for each of said plural fiber laser resonators.

25. The laser system of Claim 24 further including a light pipe adapted to couple beams output from said diode emitter array for each of said plural fiber laser resonators.

26. The laser system of Claim 24 further including a clad end-pumping configuration for coupling each diode emitter array to a corresponding fiber laser resonator.

27. The laser system of Claim 26 wherein said clad end-pumping configuration includes discrete imaging optics for imaging beams output from each diode emitter array into each fiber laser resonator.

28. The laser system of Claim 24 wherein said diode emitter array is adapted to transmit at wavelengths of approximately 1.5 microns.

29. A beam phase-locking system comprising:

first means for receiving plural single-mode beams of electromagnetic energy and providing flat-top beams as output in response thereto and

second means for combining said flat-top beams via spatial filtering and providing a collimated combined beam in response thereto.

30. The system of Claim 29 wherein said first means includes plural multiple fiber laser oscillators having integrated Bragg grating mirrors, said integrated Bragg grating mirrors representing a first end of a spatial filter included in said second means.

31. The system of Claim 30 wherein said fiber laser oscillators include Er-doped YAG crystal (Er:YAG) resonator cores.

32. The system of Claim 31 wherein said fiber laser oscillators further include dielectric cladding at least partially surrounding said resonator cores.

33. The system of Claim 32 wherein said resonator cores are approximately equivalent lengths.

34. The system of Claim 33 wherein said resonator cores are sufficiently different in length to facilitate longitudinal mode overlap among beams traveling along different resonator cores.

35. The system of Claim 34 wherein said resonator cores differ in length by more than 1.5 centimeters.

36. The system of Claim 31 wherein said Er:YAG resonator cores include YAG crystal doped with less than 0.5% Er molecular concentration.

37. The system of Claim 31 further including means for pumping said fiber laser oscillators.

38. The system of Claim 37 wherein said means for pumping includes plural diode emitters.

39. The system of Claim 38 wherein said means for pumping includes one or more pigtail couplers for coupling one or more diode emitters into each fiber laser oscillator.

40. The system of Claim 37 wherein said means for pumping includes discrete imaging optics for coupling one or more diode emitters into each fiber laser oscillator.

41. The system of Claim 30 wherein said spatial filter includes a collimating lens pair having a first collimating lens and a second collimating lens and an aperture therebetween.

42. The system of Claim 41 wherein said aperture, said first collimating lens, and said second collimating lens are positioned so that a focal point of said first collimating lens and a focal point of said second collimating lens approximately coincide at said aperture.

43. The system of Claim 42 wherein said spatial filter includes a feedback mirror positioned adjacent to one of said collimating lenses and at a second end of said spatial filter, said feedback mirror partially transmissive.

44. The system of Claim 43 wherein said first means includes beam-flattening optics positioned in front of said Bragg grating mirrors and before said first collimating lens.

45. The system of Claim 44 wherein said beam-flattening optics are characterized by hexagonal geometry.

46. An eye-safe laser system comprising:

plural Er:YAG fiber laser resonators;

plural diode pump sources coupled to said plural Er:YAG fiber laser resonators to pump said plural Er:YAG fiber laser resonators; and

a phase locker coupled to said plural Er:YAG fiber laser resonators and adapted to phase lock outputs of said fiber laser resonators to produce a single collimated combined laser beam as output in response thereto.

47. The laser system of Claim 43 wherein said phase locker includes first means for receiving plural single-mode beams of electromagnetic energy output from said plural Er:YAG fiber laser resonators and providing flat-top beams as output in response thereto and second means for combining said flat-top beams via spatial filtering to provide said collimated combined laser beam in response thereto.

48. The laser system of Claim 47 wherein said plural Er:YAG fiber laser resonators are approximately equivalent lengths or differ in length by more than 1.5 centimeters.

49. The laser system of Claim 48 wherein said first means includes beam-combining optics characterized by hexagonal geometry.

50. The laser system of Claim 49 wherein said spatial filter includes means for rejecting higher order beam modes arising from combining said flat top beams.

51. The laser system of Claim 50 wherein said spatial filter further includes means for reflecting a first portion of collimated energy back through an aperture between two collimating lenses and transmitting a second portion of collimated energy as output of said system.

52. An efficient multicore fiber laser comprising:

plural pump sources that provide input electromagnetic energy;

laser resonator cores coupled to said plural pump sources and arranged to receive said input electromagnetic energy and provide laser energy in response thereto, said laser energy travelling within said laser resonator cores; and

a spatial filter coupled to outputs of said laser resonator cores, said spatial filter combining plural beams output from said plural resonator cores into a single coherent output beam.

53. The laser system of Claim 52 wherein said laser resonator cores are optically side coupled, edge coupled, fusion coupled, and/or prism coupled to said plural pump sources.

54. The laser system of Claim 52 further including a container accommodating said resonator cores, said container internally reflecting said input electromagnetic energy to facilitate coupling of said input electromagnetic energy with said laser resonator cores.

55. The laser system of Claim 54 wherein said container is a substantially flat disk or plate designed for total internal reflection of laser energy.

56. The laser system of Claim 54 wherein said container is spherical or cylindrical.

57. A method for generating an eye-safe laser beam comprising the steps of:

obtaining plural fiber laser resonators adapted to lase at eye-safe wavelengths and

combining beams output from said plural fiber laser resonators into a single eye-safe laser beam via a cavity external to said fiber laser resonators.